Managing Change Through a Work Environment Which Promotes Forgetting

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Abstract

Changing established business processes poses many obstacles. Employees falling back into old routines is one problem, change-managers have to cope with. This paper investigates the reasons of this fall-back actions and gives insight into how this behavior can be avoided and how newly learned actions are stabilized. From a psychological perspective we propose that the presence of retrieval cues triggers old and hampers new routines. By controlling the work environment and eliminating or manipulating these cues, it is possible to ease learning. We demonstrate the cue manipulation in an experimental setting and present the preliminary results from our first experiments.

1. Introduction

As digitization advances into more and more areas of the economy, companies and their employees have to cope with changes brought about by this development. Learning has been valued because it assists a firm in outdoing its competitors [1, 2, 3, 4, 5] and adapting to a changing environment by means of altering objectives, structures and routines [6]. The employees' work environment and their tasks are directly impacted by the modification. Learning on the organizational level has to be accompanied by adaption on the individual level. Different modes of learning i.e. at the workplace or blended with on-line-courses seek to enhance the knowledge and the skills of the workforce. The theme in change projects is often to create a learning friendly environment. Especially in a production context with strongly routinized tasks and many possible sources of distraction, this leads to an enhancement of the workplace, e.g. with new mobile devices or to establishing new working-time models with the freedom to learn off-site.

The accumulation of new skills cannot be viewed without regard to the existing knowledge baseline as a starting point on top of which the new knowledge is gathered. Acquiring new knowledge is easier to adapt from a highly skilled and trained level with a lot of experience in the task. However, the baseline does not necessarily only have a positive impact on learning. As interference theory explains, new knowledge can be disrupted by already existing memories. This is slowing down learning and posing a risk for confusing the new content with older memories [7]. Also, learning results can be unstable as employees tend to fall back into old routines. This is especially true for production environments, in which routinization is written into the physical actions in the form of muscle memory and established interaction schemes. So the first research question in this paper is: What is triggering old, inscribed routines? The theoretical and empirical evidence from psychology is used to describe the fundamentals of learning and memory recall. We argue, that cues which are held available in the work environment inhibit successful adaption and learning. They invoke older routines which in turn distort or suppress the newly learned routines and tasks.

The turbulences caused by environmental or structural change can be eased by unlearning or forgetting old routines [8] In order to overcome old routines, employees have to be able to intentionally forget previously learned facts, actions and relations. Forgetting can occur accidentally by distraction or by not using the knowledge, however this can not be controlled in a work environment. So, the second aim of this paper is to present a guideline to control forgetting in a production environment and enable intentional forgetting. Drawing on the theory of cue-related forgetting [9, 10, 11], we identify relevant cues and show ways in which to control and alter those in order to aid forgetting.

The implications for the workplace are then used as hypotheses which should be investigated experimentally. The demonstration of the experiment setting and the presentation of the first, preliminary results is the third part of this paper.

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2. Theories of Learning and Forgetting

From a cognitivist perspective learning is a process of sense-making in which new information or perception is put into context with existing knowledge. As newly generated insights are consolidated and reinforced, new knowledge (a memory item) is formed. The Atkinson-Shiffrin memory model [12] explicates these stages in which a sensory input is transformed into short-term memory and is then consolidated into long-term memory, thus becoming part of the individual's knowledge base. By this rationale, knowledge always incorporates the context of the environment. This becomes virulent in the extension of the "search of associative memory"-model [13] in which specific environmental elements (cues) are associated to the learned content. In the process the retrieval of knowledge from long-term memory cues aid the search in the knowledge base. This process is unconscious. Cues are not perceived actively but unconsciously trigger retrieval processes of the memory item with the strongest association to the cue.

The model was tested in a lab-environment by means of list-learning experiments to verify the underlying assumptions. This simple setting is not easily transferred to learning in the work environment. There is usually a separation between initial learning in a classroom and the consolidation and utilization at the workplace. This separation could lead to the initial association of the new knowledge with a cue in the classroom (e.g. posters, materials or teachers), which are not found in the workplace. However, through the reinforcement of the learned content in action at the workplace, new cues (e.g. machines, instructions, team members) might develop a stronger association then the classroom cues. Therefore, the presence of retrieval cues and the enactment of learned routines is a reinforcing cycle which leads in extreme cases to the reflex-like triggering of actions, the so called muscle memory. This is observable in production environments with a thoroughly defined sequence of actions, which do not differ in their execution.

Routinization has advantages in this environment with regard to its execution speed and accuracy, yet it stalls when the sequence is disturbed and certain steps fail. Also, the change of these routinized tasks is likely to fail since the employees fall back into the old routine. To achieve adaptability, specific objectives and tasks need to be forgotten in order to focus on currently relevant objectives and to learn new routines [14, 11]. The theory of unlearning [15, 16, 17, 18, 19, 20, 21, 22] argues that the installment of a new routine will actively overwrite of the old one, when it is enforced and enacted sufficiently. There is no active suppression of the old routine, it simply looses retrieval strength to be recalled. There is no active forgetting, since information in unlearning is not evaluated but just abandoned when a new (not necessarily better) option is available [23, 24].

Early research considered forgetting as a malfunction of human information processing. However, recently it has been argued, that forgetting is an essential function of the human brain in order to adapt to new circumstances by overwriting, suppressing or sorting out knowledge which is no longer of use [11, 25, 26, 27]. Forgetting is in general defined as inhibiting the recall of previously learned information [28]. The forgetting process is different in short-term and long-term memory.

Brown [29] and Peterson and Peterson [30] argue, that the traces of memory items, which have not been consolidated yet, decay over time. Without the trace, the memory item cannot be recalled and therefore cannot be consolidated into long-term memory. Rehearsing the learned content again fortifies the memory and prevents decay. Another explanation of forgetting in short-term memory is given by Atkinson & Shiffrin [12], they argue, that there is only a limited amount of storage capacity. When this capacity is exceeded, memory items are displaced. The chance of displacement differs with the time passed since learning. It is more likely to recall items which have been learned first or last in order. Intermediate items are more often forgotten [31].

Again, the findings stem from lab experiments but can be transferred to real-life situations. So the learning of changed tasks in the workplace is governed by the likelihood by which the newly learned content can be forgotten before it is consolidated. We argue that in short-term memory forgetting is obstructive to learning. Without the chance to rehearse properly and with the cognitive load of processing too much information, learning is likely to fail. Both aspects are influenced by the work environment and recall processes from the long-term memory. The work environment can provide distraction in the learning process. Sensory inputs (cues) need to be processed during learning, which might disrupt constant rehearsing and increases the cognitive load. This in turn inhibits the consolidation. Regarding the short-term memory, a distraction free learning environment should be preferred, to allow a steady consolidation to long-term memory.

Forgetting in long-term memory can be described by means of interference. Recalling specific memory items is inhibited because other memories disrupt the process, they interfere [32]. This is more likely when memories are similar [33]. The relationship between new and old knowledge can be two-fold.

Proactive interference inhibits learning new tasks, because an existing knowledge interferes. Retroactive interference on the other hand inhibits the recall of older memory items due to newly learned content. Interference also offers an explanation why old routines are triggered instead of newly learned or why newly learned activities are not executed properly. The different memory items are confused while recalling and the interference also effects the short-term memory in form of distraction. So problems in consolidating new information into the existing knowledge base can arise, when existing knowledge obstructs the interpretation of new information and impedes the evaluation of alternative ways [34]. The confusion of memory items also generates uncertainty about goal-attainment [35] and problems with the causal connections between events [36]. Selective, intentional forgetting from the long-term memory is therefore a functional part of information processing and learning.

While accidental retrieval of old knowledge and the fall-back into old routines can be observed, it is unclear how the faulty retrieval is triggered. Retrieval cue theories [9, 10, 11] propose that while a memory item is still present in long-term memory, it cannot be recalled due to a missing cue. Tulving [37] suggests that cues can be distinguished into external and internal cues:

- External cues are found in the environment of the individual, e.g. objects, sounds and smells in the presence of information encoding and retrieval.

- Internal cues on the other hand considers the state of the individual during encoding and retrieval. This can be mood [38] or mental capabilities [39] of a person.

Retrieval is more successful if the external or internal cues that are present during encoding are also available during retrieval [37]. So fall-back into old routines occurs due to an accidental retrieval triggered by associated cues. This in turn means, that by controlling the work environment and the presence of cues, it is possible to prohibit the accidental retrieval and fall-back.

Internal and external cues are not equally accessible for management manipulation in a controlled change process. External cues like work materials, instructions and team members which invoke older memories can be avoided or removed while external cues with a strong association of new tasks and information (like new interfaces and instructions) should be presented in the work environment. By controlling the external cues' interference with existing knowledge and the accidental retrieval of older memory items can be avoided. Internal cues on the other hand cannot be easily manipulated. In lab experiments the mood of the participants was altered or their mental capabilities were impaired e.g. by alcohol [39]. This is hardly applicable in work environment. Therefore, when talking about cues and cue manipulation, we are referring to altering external cues.

We distinguish two modes in which cues can effect the retrieval:

1. a cue is linked to different memory items through additional learning (cue overload) and therefore every additionally learned cue association weakens the existing cue association [11, 10].

2. the association between retrieval cues and memory item is unlearned when the cue is not available and subsequent activity leads to weakening of the cue-target association [10, 186].

With the first mode of cue related forgetting, overloaded cues possess less diagnostic value for a particular memory item. One cue could invoke different items, which in turn interfere with one another. This first leads to confusion. Furthermore, it is likely that the false memory item is recalled. When a cue is overloaded the retrieval strength of the associated memory items is decisive. Since older, consolidated memory items possess a greater retrieval strength, they are more likely to be recalled. The consequence of cue overloading in the work environment is, that when no modification of the environment occurs, cues (machines, team members, etc.) are associated with both older and newer memory items. The former have a higher chance of recall, leading to the fall-back into old routines, suppressing the newer memory items. This leads directly to the consolidation and reinforcement of the older routines and the repression of new memory items. The second mode is connected to the availability of the cue. If the cue is not held present, the connection between cue and memory item decays. Given that the memory item cannot be recalled otherwise, it is forgotten. Keeping cues for old routines present will consolidate these associations and lead to cue overload, while removing them frees up cognitive capacity to develop new associations. This process can be amplified by the presence of a new cue which reinforces the newly learned association. It becomes clear, that the manipulation of retrieval cues can be used to design a learning- (and forgetting-)friendly work environment. Yet most forgetting processes are unintentional and undirected.

The concept of intentional forgetting [27, 40] adds the individuals' motivation to the process. It is defined

as the motivated attempt to limit the future recall of a defined memory element. In an organizational context certain memory items are more valued than others. When changing processes and tasks, the old memory items are not helpful anymore since they compete with the correct (new) memory item. The old items therefore need to be forgotten [41]. The intention to forget by minimizing the accessibility of a memory item or its habitual retrieval leads to an active repression of the cue-target association. This implies two different approaches by which routines can be intentionally forgotten: motivation and situational strength.

The motivational aspect requires the insight and awareness of the individual, that the old habituated routine is unwanted. Especially in change projects there is often a strong emotional attachment to old routines, hence motivation has to be acquired by measures in change management. The motivational aspect is not directly addressed in this paper, since it is not associated with the work environment.

Another way to control intentional forgetting is by providing cues for desirable and unwanted behavior. This cue manipulation does not stem from the individual but is done by a third party, e.g. management. This concept is called situational strength [42] and it results in psychological pressure on the individual to show or repress certain behavior. In case of the presence of competing cues, situational strength triggers an active decision process, selecting the organizationally preferred course of actions. Means by which the situational strength can be defined are

1. the definition of stimuli,

2. limiting the freedom of behavior, and

3. reinforcing or punishing wanted respectively unwanted behavior [43].

Regarding the first research question, it can be shown that strongly routinized knowledge and the presence of retrieval cues is triggering fall-back behavior and is impeding the learning of new tasks and routines. We have shown that forgetting can have functional and dysfunctional aspects in change processes. While it is dysfunctional to forget newly learned tasks in short-term memory it might be functional to forget interfering aspects from the long-term memory. Furthermore, it can be stated that the manipulation of retrieval cues is a fruitful way to control learning and forgetting in the work environment. In order to derive practical implications for the management of process change, it is necessary to relate these findings to practical aspects and outline ways in which the cues can be manipulated.

3. Identifying relevant cues and how to alter them

Cues can be everything an individual is confronted with during learning and the execution of a learned action [37]. This broad definition can be narrowed down for the work environment. Kluge & Gronau [44] provide a classification of retrieval cues for organizational routines. They differentiate four cue types:

- Sensory cues, which are the basal cues such as smell, taste, light, color, sound, tactile perceptions, temperature, or physical pain that trigger the recall of certain memory items (visual, olfactory, oral, tactile),

- Time and space cues, which include stimuli indicating location (e.g. production site) and time (of year, week, day) of the execution of the routine,

- Routine-related cues, which include actor-related, object-related, sequence of task-related and information-related cues, and

- Situational Strength Cues, which include implicit or explicit cues provided by external entities (e.g. supervisors) regarding the desirability of potential behaviors [42]

While the former two types are highly individual and can not be altered easily, the latter types are at the core of the definition of business processes which form the work environment.

As a process we define "a specific ordering of work activities across time and space, with a beginning and an end, and clearly defined inputs and outputs: a structure for action." [45]. In addition, we define a routine as a "multi-actor, interlocking, reciprocally triggered sequences of actions"[46]. While a process is a predefined management device to control work-flows in an organization, a routine is an repeatedly enacted instance of this process by a group of individuals. Activities or actions are central in the work environment. Each action has resources associated to it, which act as routine-related cues. They can be further classified into objects such as machines, tools and materials with which the actor is confronted. Furthermore, other people, especially team members and colleagues act as a different type of cue. While objects are passive in the work routine, team members are active communication partners. In interaction intensive activities the their retrieval strength exceeds that of objects. The third type of cue that ties together business processes and work routines is the task, respectively the task description and

instruction. This cue can either be overt e.g. in a process handbook or it can be tacit by individual instruction. This information cue is tightly coupled with the incentive system an thus tries to influence the individual to enact the work routine as the process specifies it. As mentioned above, situational strength cues are guiding the intentional side of forgetting. The work environment encompasses all of these aspects. We therefore can define the work environment as a collection of tasks, materials, persons, tools, instructions and incentives which constitute the context of daily business routines. In order to alter this work environment in accordance to process changes, each element can be modified, eliminated or made salient, in order to suppress the old routine and promote newly learned skills.

The following section describes how each cue type could be controlled. This results in a set of hypotheses, which are in part tested in an experimental setting.

3.1. Tasks and instructions

Tasks are the central piece in the work environment. They impose a structure on all activities and supply the needed resources to transform the input to the expected output. They describe what is supposed to be done and in which sequence needs to be followed. In order to meet the organization's expectation and to measure success and efficiency, tasks are explicitly defined. The task definition therefore acts as a cue for the employee to recall the trained behavior.

Task descriptions are usually captured in a process manual, which instructs the employee. Not only the sequence and content of the actions, but also the expected outcome (e.g. product quality, documentation) are relevant information for the employee. The task description triggers learned behavior, even though the task execution is in most cases over-learned and routinized, . The presence of old task descriptions and instructions could hamper learning the new task. Old routines and goals are recalled accidentally. A learning and forgetting friendly work environment pays specific attention to the instructions which it provides. It takes care, that old instructions are nowhere to be found, neither digitally, in print nor in nudging elements like posters or stickers promoting the old goals and actions. New descriptions and materials are made salient in order to consolidate the cue-memory association.

Hypothesis 1: Eliminating old instructions from the work environment while making new instructions salient will foster the forgetting of the old routines and thereby stabilizing the newly learned routine.

3.2. People

Routines are multi-actor and interlocking and involve the interaction with other employees. People therefore constitute another cue in the work environment. This is especially true in collaborative situations with collective problem solving. The actions of other employees involved in the process are not regarded abstractly. They are always tied to a specific face. Also, the feedback from other employees and the work climate are person specific. In collaborative tasks employees scan their surrounding for recognizable faces. Familiar faces can trigger a sequence of memories, e.g. tasks that have been forgotten or objectives that have to be met.

There is also a social dynamic, when all employees in a team remind each other of old routines. The enactment of an old interlocked action sequence by one actor is resumed by other team members propagating the old routine and reinforcing the process for the entire team. For a fruitful learning and forgetting environment it is therefore necessary to change the composition of teams.

Hypothesis 2: Changing the group composition, e.g. by reassigning teams, will suppress the retrieval of the old routine and lead to a faster stabilization of the new routine.

3.3. Objects

The work environment furthermore consists of a range of objects, with which the employee is interacting or which surround its workplace. In most cases these objects are tools needed in the work process. These tools remind the employee of actions. In a manufacturing environment color-coded handles are used to easily identify the relevant tools and evoke the trained memory item. Keeping this coding can lead to the fall-back into the old routine. Also, user-interfaces are strong cues in the work environment. In most cases the operation of computer-based machinery becomes routinized quickly. The location of the appropriate buttons and the fields in which the relevant information is presented are remembered easily. Routinization therefore leads to machine operation which is not actively reflected anymore. So, keeping the old interface can easily trigger the old behavior and fire a sequence of actions with the machine interface, which are not wanted anymore.

It is recommended to change the interface in the training setting in order to create dissonance, which feeds back into the learning loop loosening the association between the old task and the interface and manifesting the connection to the new task. This

however is often not easily achieved. First of all the user's frustration with the new interface can lead to negative effects in learning, furthermore the change of the interface is not easily done especially in a manufacturing environment. Since the newly learned process is not stable yet, this change will also lead to lower performance and more errors.

Hypothesis 3: Altering the user interface of a machine or the look and classification of a work-piece will reduce the number of fall-back actions.

Since the test of this hypothesis is not easily transferable into practical implications, it is not tested in our current experiments. All tools and user-interfaces are kept stable.

3.4. Incentives and Punishment

The forth aspect guiding employees in their work is the incentive and punishment system which signals desirable actions and outcomes. This incentive system should be in sync with the companies goals. Misplaced incentive can lead to undesired outcomes for the overall system. Incentives and punishment can work on different levels.

Incentives can be provided for the achieved output. Errors are therefore penalized. This can be ineffective in the learning phase, since the routinized old task performs better than the newly learned tasks. By incentivizing the output, management is indirectly reinforcing the old routine. It is likely that the employee falls back into the old routine when under stress. It is therefore recommended easing the output oriented incentive system during the learning phase in order to provide slack and cognitive resources for the employees to loosen the association with the old routine and establish the new routine.

At the process level the execution of specific tasks is punished or incentivized. It aims directly at the learning process. New actions are thereby reinforced while old routines either do not receive any stimuli or even get penalized. However, it is hard to monitor the process reliability of the employees closely. In the experiment setting this is possible, in a real scenario it would require data collection and employee observation which is problematic.

Hypothesis 4: Providing incentives for the new action and punishing the execution of an old routine will lead to active suppression of the old action in favor of the new routines.

4. Experimental Validation

Most of the studies in section 2 are very limited in scope. Most experiments draw their conclusions from so called list-learning experiments, where the participant is confronted with different word-lists under varying conditions. There is doubt, that these findings can be reproduced in real-life. So in order to test the hypotheses laid out above, we developed a close to real-life production setting in which a production process is first learned and later altered. The following section introduces this setting and the outlines the data-sources used. We furthermore present first preliminary results from the first experiment runs. A more thorough description of the experiment, the measurement of the variables, the results and the underlying analysis can be found in [47].

4.1. Testing intentional forgetting

In contrast to the experimental setup currently used in forgetting research, we wanted to move closer to real-life scenarios. Since we are interested in intentional forgetting in organizations, a setting with collaborative goal-attainment was chosen. In two experiment sessions the participants are learning and re-learning a production process. The experiment consists of three aspects: the experimental environment, the collaboration process and the presented cues.

The experimental environment is a research and learning factory for cyber-physical systems as presented in figure 1. The core of the environment is a hybrid simulation providing physical objects like a transport system and a manufacturing robot as well as machine interface simulations which are enhanced with video and sound material from a real production site. Participants are interacting with this environment and are instructed to manipulate a simulated work-piece. This work-piece consists of a touch screen display and a mini computer inside a metal box. During the manufacturing process, the work-piece displays different stages of the product from raw material to an completely packaged good.

Figure 1. Experimentation environment

The second element of the experimental environment is the production process. The participants produce hip-joints and are instructed to pay

special attention to the product quality and seamless documentation of their actions. The production process was recorded at an actual production site and modified to meet the experimental requirements. Modifications had to be made in order to have comparable tasks for each participant and to have the opportunity to present the cues to the participant. The process is collaborative since each participant relies on the other to produce a usable artificial hip-joint. There are three main routines:

1. milling and grinding,

2. labeling and polishing, and

3. disinfecting and packaging

Within each routine there are eight actions. The actions are either manual, documentation or machine operation tasks. Manual tasks are e.g. cleaning and measuring the work-piece, supplying the polishing tool or package the work-piece. Documentation tasks concern either data read from the machine or documenting the results of the interaction with the work-piece. Machine operation tasks involve direct interaction with the machine interface. The participants select specific production programs, start and monitor the production and operate the transport system. For each action a cue is presented either in form of a tool, a machine, the work-piece or the production documentation.

We distinguish between cues which are kept present throughout the experiment, cues that are present but change importance in the process and cues which are eliminated between the experiment sessions. The first class of cues are tools which are used in the initial and the changed process in the same way. When packaging, the third participant is e.g. using the same material throughout the processes. Also, scanning of the work-piece is done with the same QR-reader. The second class of cues are tools that have been present in the initial process but their handling and importance changes in the altered process. The first participant e.g. uses a caliper to measure the work-piece. In the first process he measures in cm in the second process in inch. The third class of cues is eliminated from the first to the second session. These cues define the experiment conditions outlined below.

The experiment process consists of three pieces:

1. The first session takes approximately two hours in which the participants are first instructed about the experiment's objectives and the safety in the lab. Afterwards they receive the instructions for the routine. They are then allowed to produce three products with the instructions. The first session ends with a 40 minute production without the instructions.

2. Following the first session, the participants re-enact the production process with a learning-app. They are instructed to learn once a week with seven days in between.

3. After exactly 21 days the participants return to the lab for the second session. Here they are presented with a story about the process change (hostile take-over of the company). The then receive the new instructions for one run. These instructions contain changes in tasks, measurements, tools and machine operation. Each change is theoretically grounded in the association between a memory item and retrieval cue. Afterwards they should again produce for 40 minutes with the newly instructed process.

We assume that cognitive abilities (intelligence, creativity), self-sufficiency and the socio-demographic status act as control variables. The connection between learning/forgetting and the cognitive abilities is clear, since the participant which score higher in these tests can also comprehend the presented material more easily. Self-sufficiency is assumed influence the forgetting activity since persons who are more self confident can better cope with the changes introduced in the experiment. Socio-demographic data is collected in order to assess age, gender and educational effects as well as effects from prior experience e.g. working in production environment. Both lab-sessions are therefore accompanied by surveys regarding these control variables.

We are conducting four different types of experiments, each is representing a controlled change in the retrieval cues or conditions. The first session remains the same in all experiments, only the second session is altered. In the first experiment the team composition is changed. We remove one team member and replace it with an already trained participant. The second experiment varies the presence of the instruction material. Participants are presented with either the initial or the changed instruction. Furthermore, we include the conditions of both instruction materials and no materials at all. The third and forth experiments is addressing the situational strength cues by either rewarding or punishing the participants for their process performance. There is an overall of 880 participants (mostly students) distributed over the four experiment types.

During the experiment sessions all participants are wearing eye-tracking devices to record their visual focus and the actions around the machines. Also, all documentation is analyzed to determinate errors in the production process. Furthermore, the interaction

with the machine interface is logged with every click, enabling a thorough investigation of operation sequences. To determine forgetting, we use the errors in the second process as a proxy. We argue, that errors in the second process occur due to interference with the old routine and can hence be attributed to failed intentional forgetting.

Currently we have successfully conducted the pretests and stabilized the experiment environment and are now conducting the first experiment type. In the following section, the first preliminary results are presented.

4.2. Preliminary results

At this point it is not possible to draw any conclusion with regard to the effect of the cues since only 18 persons have participated thus far. However, we could demonstrate that there is no significant difference between the three error sources: on the machine, around the machine and in the documentation (figure 2). This means that there is no bias in the experiment, where errors can occur. This is a sign of the experiment's validity.
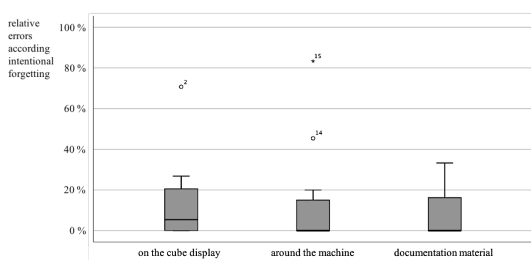
Figure 2.   Relative Errors made according to intentional forgetting (t4) for the three action element categories

Furthermore, we could test in how far consolidated memory items from the first session influence the performance in the second session. It is suspected that routines which are stable in the first session will interfere with the new process instructions in the second session. We therefore used a median split for the results in the first session and compared the participants with high and low proficiency.

As figure 3 shows, there is a clear distinction between both groups. Participants which performed well in the first session had problems coping with the changes in the process, while participants with little process consolidation showed lower error scores. This indicates that changes are harder for the participants, when they routinized their activities. As the experiments progress, we hope to find significant relationships
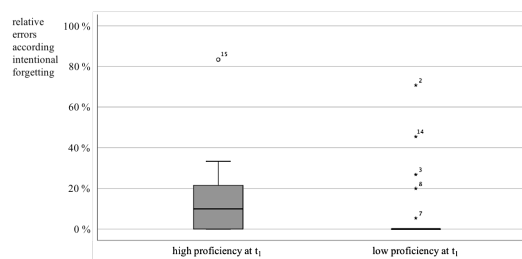
Figure 3.   Relative Errors made according to intentional forgetting (t4) for the action elements with high and low proficiency in t1

between the cue manipulation and the forgetting performance.

5.   Discussion and Outlook

We have shown in this paper in how far existing knowledge can impede the learning of new actions and processes. Drawing from psychological theories of learning and forgetting we stressed that the work environment plays an important role in learning and retrieval processes. Especially in highly routinized work environments, the surrounding objects, sensory information and the social context act as cues to retrieve the learned activities. Changing the behavior becomes harder when this knowledge is consolidated since interference occurs between old and new memory items. This is amplified by the presence of cues triggering old processes.

We have transferred the findings from psychological lab tests to practical implication for changes in the work environment. Four central cue categories governing the forgetting process were identified: tasks and instructions, people, objects and incentives. Organizations can manipulate, present or eliminate these cues in the change process to accelerate learning and impede the fall-back to old routines. Using an experimental setup, the effects the elimination of selected retrieval cues is tested. We could show, that our experiment captures forgetting validly. The first preliminary results suggest that there is a connection between the consolidation of routines and the problems with learning new actions.

With the extensive data collected in the experiments we hope to supply a valid guideline of significant effects of cue manipulation. This will be a contribution to theories of learning and forgetting. It will also supply the groundwork for practical implications. Business processes are central in determining where relevant cues are present. In order to easy the process of identifying and manipulating the cues, business modeling notations

need to be enhanced with the potential to distinguish different knowledge or memory items involved in tasks and their association to cues in the environment.

Furthermore, other tasks need to be tested. We have concentrated on highly routinized tasks in a production process. Cues might show different effects in conscious decision-making processes with social deliberation. Also, the effect of internal retrieval cues and retrieval cascades has not yet been addressed sufficiently. This shows that by approaching organizational change from the forgetting perspective, new insights and practical implications can be drawn. This will enable managers to better guide the change in companies and preventing fall-backs and dysfunctional learning.

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